

Advanced characterization of aerosol size properties from measurements of spectral optical depth using the GRASP algorithm

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This study evaluates the potential of using aerosol optical depth (τ_a) measurements to characterize the microphysical and optical properties of atmospheric aerosols. With this aim, we used the recently developed GRASP (Generalized Retrieval of Aerosol and Surface Properties) code for numerical testing of six different aerosol models with different aerosol loads. The direct numerical simulations (self-consistency tests) indicate that the GRASP-AOD retrieval provides modal aerosol optical depths (fine and coarse) to within 0.01 of the input values. The retrieval of the fine mode radius, width, and volume concentration is stable and precise if the real part of the refractive index is known. The coarse mode properties are less accurate, but they are significantly improved when additional a priori information is available. The tests with random simulated errors show that the uncertainty in the bimodal log-normal size distribution parameters increases as the aerosol load decreases. Similarly, the reduction of the spectral range diminishes the stability of the retrieved parameters. In addition to these numerical studies, we used optical depth observations at eight AERONET locations to validate our results with the standard AERONET inversion products. We found that bimodal log-normal size distributions serve as useful input assumptions, especially when the measurements have inadequate spectral coverage and/or limited accuracy, such as lunar photometry. Comparisons of the mode median radii between GRASP-AOD and AERONET indicate average differences of 0.013 μm for the fine mode and typical values of 0.2–0.3 μm for the coarse mode. The dominant mode (i.e., fine or coarse) indicates a 10 % difference in mode radii between the GRASP-AOD and AERONET inversions, and the average of the difference in volume concentration is around 17% for both modes. The retrieved values of the fine-mode $\tau_a(500)$ using GRASP-AOD are generally between those values obtained by the standard AERONET inversion and the values obtained by the AERONET Spectral Deconvolution Algorithm (SDA), with differences typically lower than 0.02 between GRASP-AOD and both algorithms. Finally, we present some examples of application of GRASP-AOD inversion using moon-photometry and the air-borne PLASMA sun-photometer during ChArMEx summer 2013 campaign in the western Mediterranean.

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